18-284

Before the
FEDERAL COMMUNICATION COMMISION
Washington, D.C. 20554

In the Matter of	)	
	)	
Request by Metrom Rail, LLC	)	File No. _____
For Waiver of Sections 15.519(a) and	)	
15.519(c) of the Commission's Rules	)	

To: Chief, Office of Engineering and Technology

REQUEST FOR WAIVER

Metrom Rail, LLC ("Metrom"), pursuant to Section 1.3 of the Federal Communications Commission's ("FCC" or "Commission") rules, respectfully requests a waiver of Sections 15.519(a) and 15.519(c) of the Commission's rules. The requested waivers would permit: (1) Metrom to obtain a grant of equipment authorization for an ultrawideband ("UWB") positive train control ("PTC") system in the 3.272-5.014 GHz band that operates above the current radiated power emissions limit for some limited cases where a directional antenna is necessary; and (2) Metrom and rail authorities to install and operate the AURA PTC System as fixed wireless infrastructure under the handheld UWB device rules. The requested waiver is for initial operation in the Boston metropolitan area with the Massachusetts Bay Transportation Authority ("MBTA"),in the New York City metropolitan area with the New York City Metropolitan Transportation Authority ("MTA"), in the Los Angeles County Metropolitan Transportation Authority ("Metro") and, ultimately to expand to the rest of the United States should certain conditions be met. The requested waiver would serve the public interest by: (1) promoting safety for railway passengers and personnel by helping to prevent train-to-train collisions, over-speed derailments, unauthorized train movements in work zones, and the movement of trains through

switches left in the wrong position;[1] (2) enabling PTC to be deployed to public transit and short rail train systems in a cost-effective manner; and (3) advancing the Commission's efforts to support railway systems' efforts to comply with Congressional mandates to implement PTC systems.

I. BACKGROUND.

A. Metrom Rail.

Metrom Rail, founded in 2010, is a U.S.-based manufacturer located in Crystal Lake, Illinois. The company specializes in working directly with its customers to develop, build, and integrate technology products that help transit and freight organizations improve safety and efficiency. Metrom has developed the innovative AURA positive train control system based on UWB technology. Because AURA is low cost and designed for quick installation, it is ideal for railway systems of all sizes and can be easily integrated into both new and existing transit rail systems. Further, Metrom's worker protection and collision avoidance solutions help transit and freight organizations protect and monitor railway workers and equipment. Metrom designs, builds, and tests its complete line of products at its Crystal Lake headquarters.

B. Positive Train Control

Modern commuter railroad locomotives can weigh upwards of 140 tons and travel at speeds over 80 miles per hour while pulling railcars filled with people.[2] While rail travel is generally very safe, accidents do happen. And, because of the sheer size and speed that trains can travel, the results of an accident can be devastating. One of the worst was the September 12,

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[1] *See* Railroad Safety Enhancement Act of 2008 (Pub.L. 110-432) Section 104, Implementation of positive train control ("RSIA").

[2] *See, e.g.,* MotivePower, Inc. Brochure for MPXpress diesel-electric commuter locomotive at https://www.wabtec.com/uploads/outlinedrawings/MotivePowerXpress-Commuter-Locomotives.pdf. This is the same model of locomotive used by the MBTA.

2008 head-on collision of a Southern California Regional Rail Authority Metrolink train, consisting of one locomotive and three passenger cars, with a Union Pacific Railroad freight train near Chatsworth, California. The NTSB concluded that had a fully implemented PTC system been in place at the time of the accident, it would have intervened to stop the Metrolink train before it passed a red signal and the collision would not have occurred.[3]

The aftermath of this accident provided motivation to Congress to pass the Railroad Safety Enhancement Act ("RSIA") of 2008.[4] This Act defines PTC as, "a system designed to prevent train-to-train collisions, over-speed derailments, incursions into established work zone limits, and the movement of a train through a switch left in the wrong position." The RSIA of 2008 mandated, *inter alia*, that each Class I railroad carrier and each entity providing regularly scheduled intercity or commuter rail passenger transportation must implement a PTC system by December 31, 2015.[5]

Most PTC implementations to date have been based upon a complex series of equipment incorporating monitoring on the locomotive, a wayside segment that monitors track signals and conditions and communicates authorization for a locomotive to move, a back office segment which determines whether a specific train has authorization to move, and a wireless communications segment to link all these components together.[6] This equipment is costly and time-consuming to install. In addition, the wireless communications segment has generally relied on obtaining an FCC license to use spectrum in the 220 MHz band. Because this spectrum

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[3] *Id.*
[4] *See* RSIA.
[5] *Id.*
[6] *See, e.g.,* Association of American Railroads website at: https://www.aar.org/article/freight-rail-positive-train-control/.

had been previously licensed, railroads have had to obtain rights from license holders. This has also proven to be a time-consuming and costly process.[7]

For transit agencies that do not share track with Class 1 freight, the options for automatic safety systems includes CBTC (Communication Based Train Control). Like PTC, CBTC also has several implementation drawbacks such as installation time and system cost.

C. The AURA Positive Train Control System.

The Metrom Rail AURA Positive Train Control System is the first transit-specific train control system of its kind and solves many of the drawbacks of the more traditional PTC, CBTC approaches. Because the AURA PTC System relies on relatively low cost unlicensed UWB devices and eliminates the need for back office integration, it is at least 50% less expensive and can be implemented in a fraction of the time compared to PTC systems using the traditional approach. This innovation led to Metrom being awarded a Genius Grant from the MTA Genius Transit Challenge in March 2018 due to its innovative approach to modernizing train signaling and control.[8] In making this award, the MTA stated that, "[a] UWB-based network has the potential to provide precise and accurate locations for subway cars within centimeters. UWB sensors can also be placed in work trains and even on personnel, to add an additional level of safety for track workers and contractors working near passenger trains."[9] The MTA stated that

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[7] *See, e.g.*, United States Government Accountability Office, Report to the Chairman, Committee on Commerce, Science, and Transportation, U.S. Senate, *Positive Train Control*, Report No. GAO-13-720 (Aug 2013) available at: https://www.gao.gov/assets/660/656975.pdf. *See* page 25 ("PTC implementation will cost commuter railroads a minimum of $2 billion. Finally, commuter railroads report that obtaining radio frequency spectrum—essential for PTC communications—can be a lengthy and difficult process. FCC directed commuter railroads to secure spectrum on the secondary market.44 According to the FCC, spectrum is available in the secondary market to meet PTC needs. ... While freight railroads have secured most of the spectrum needed for PTC implementation, commuter railroads have reported difficulty acquiring spectrum in the 220 megahertz (MHz) band, which is required to operate the data radios that communicate information between PTC components.").

[8] *See* "MTA Announces 8 Winners of MTA Genius Transit Challenge", MTA Press Release (Mar 9, 2018) at: http://www.mta.info/press-release/mta-headquarters/mta-announces-8-winners-mta-genius-transit-challenge.

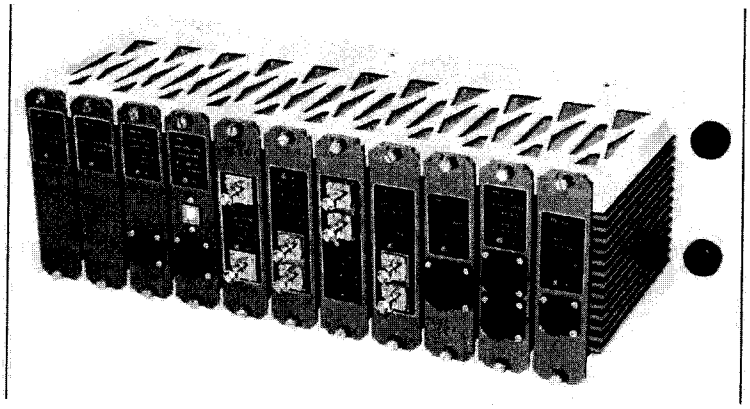
[9] *Id.*

prior to the Genius Challenge, estimates for modernizing the New York City subway signal system ranged from 40 to 50 years, with a cost of tens of billions of dollars.[10] The MTA indicates that it plans to incorporate UWB in future signaling projects to achieve a modern signaling system at lower cost and in a more expeditious timeframe than current estimates.[11]

Over the last six years, Metrom Rail's AURA Collision Avoidance System has been installed in over 3,000 maintenance-of-way vehicles for Class 1 railways throughout the U.S. and Canada.[12] It has been so successful that not a single accident has occurred while the system was operational, preserving lives, avoiding injuries, and saving millions of dollars in equipment damage. The system uses a GPS antenna within four inches of the UWB antenna with excellent GPS performance. In addition, no incidents of harmful interference have been reported due to operation of the mobile system throughout North America.

The AURA PTC System is based on a modular approach that allows transit agencies to select and deploy functions that meet their own unique requirements and to expand the system by simply adding new modules rather than additional hardware. This module is shown in the figure below.

[10] *See* Vantuono, William C., "MTA Genius Transit Challenge winners announced," Railway Age (Mar 9, 2018) available at: https://www.railwayage.com/passenger/rapid-transit/mta-genius-transit-challenge-winners-announced/.
[11] *Id.*
[12] In addition to the AURA PTC system, Metrom has a full suite of railway safety related products incorporating its collision avoidance system, including the AURA Maintenance of Way Utility and the AURA Roadway Worker Protection System. *See* Metrom Rail's Sensor Solutions web page at: https://metrom-rail.com/railway-sensor-solutions.



The AURA PTC System integrates several core technologies:

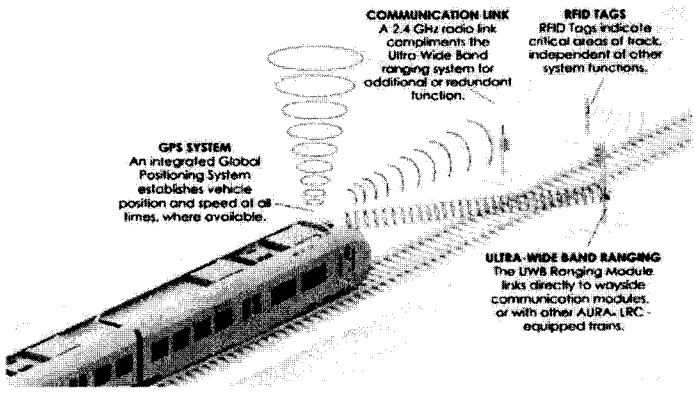
- Ultra-Wideband RF – Allows accurate and reliable range information without multipath distortion effects that limit traditional PTC systems.
- Sensor Integration – Used to determine track identification to control localized train behaviors such as speed limits, berthing locations and work zones.
- 2.4/5GHz Data Communication Network -- Facilitates communication between track-based assets.

A fully functioning AURA PTC System contains several modules:

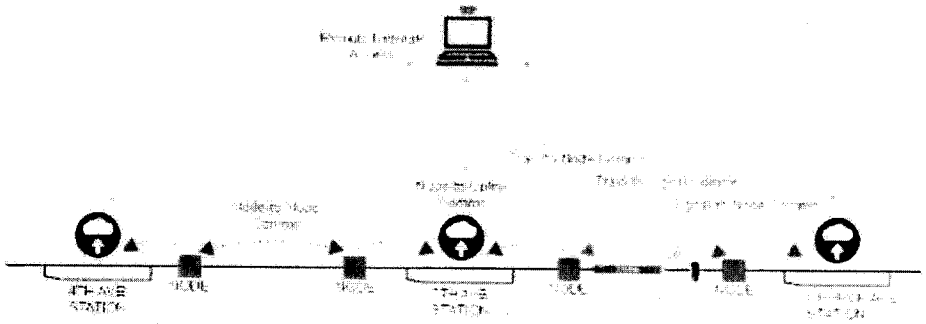
- UWB Module – Mounted on the train-and contains the UWB and RF antennas and is the primary communication system between a train and other wayside modules
- Signal Module – A wayside module consisting of an integrated signal assembly with radios for transmitting signal presence and state.
- Train Control Module – The control center that is the main interface for all modular on-board functions.
- RFID Modules – Mounted on the train exterior and used to identify key locations or conditions within the system, such as speed limits.
- User Interface Module -- Provides operators with information on upcoming signals and track conditions as well as alerts of operating rule violations and a countdown until brake intervention will occur.

The MBTA system architecture, as shown in the figure below, is comprised of communication and sensing equipment installed at various points in a transit system to affect an automatic train protection system capable of stopping a train when the operator fails to do so

under certain unsafe conditions. The installations communicate with each other, exchanging status information and cooperating to determine the distance between them. This information allows the system to determine if an unsafe condition is developing (*e.g.*, approaching too close to another train on the same track or approaching a restrictive signal too fast to stop before reaching it) and alert the operator to act to mitigate the situation. If the operator fails to act in time, the system will apply the train's brakes to stop the train. The distance between installations is contingent on the location of signals and switches and will vary depending on location.



The MTA system architecture (depicted in the figure below) builds on the MBTA architecture with the addition of UWB anchors that relay train location, direction, and speed to a central office while providing the train with system data such as switch position, signal aspect, speed limit, and movement authority. The anchors are placed approximately every 200 meters in the subway and designed so that the train always ranges with two anchors at any given time for redundancy. A track map on the train ensures that the train knows which anchors it should range with based on current location to flag if an anchor is having an issue.



The AURA PTC System core technology is the Time Domain PulsON 440 UWB module.[13] This highly sophisticated transceiver uses two-way time-of-flight ranging to measure the distance between trains or between trains and wayside modules with an accuracy of 2 cm.[14] The PulsON module can simultaneously provide range information, transfer data, and operate as both a monostatic and multistatic[15] radar to provide multiple functionality to train systems in real time. Finally, the PulsON module supports 11 independent communications channels to provide redundancy as well as to maximize information flow and avoid interference.

D. Experimental Licenses.

Metrom has been working with transit agencies to demonstrate the capabilities of the AURA PTC System as well as to better understand the best installation configurations for the UWB equipment. Metrom successfully demonstrated the AURA PTC System in Boston along the MBTA green line between August, 2017 and February 2018.[16] This demonstration consisted

[13] The PulsON 440 UWB Module has been approved by the FCC as a modular transmitter – FCC ID Number: NUF-P440-A.

[14] Two-way time of flight ranging is based on sending a signal between two or more transceivers. A data packet is sent from a requester station to a responder station and a corresponding response packet is sent back to the requester station. The time delay or time of flight between initiating the request packet and receipt of the responder packet is used to determine distance between the two points.

[15] A radar in which the transmitter and receiver are co-located is a monostatic radar. A multistatic radar is composed of a transmitter and several spatially diverse receivers. If there is only a single non co-located receiver, the radar is bistatic.

[16] *See* experimental STA, Call Sign WL9XMB.

of completion of an MBTA supplied test plan in which the agencies past accident and incident occurrence scenarios were recreated in order to determine if the AURA PTC System would have successfully intervened. These tests included red signal overruns, collision avoidance, and speed limit compliance, performed in a variety of terrain as well as commercial, residential, and urban areas, both above and below ground. The UWB modules operated with a 2 gigahertz bandwidth across the 3.272-5.014 GHz band at 1 mW peak EIRP, or 74 nW average EIRP. Additionally, 4 wayside signal modules and RFID modules were also installed along the tracks. Nominally, the wayside signal modules were 100 meters apart to ensure constant communication to the train as it travelled down the tracks. During this demonstration, there were no reported instances of harmful interference caused to any authorized radio system.[17] Metrom Rail's UWB AURA System completed all the required testing, and advanced to the final selection process before a contract is issued.

Currently, Metrom is also demonstrating the AURA PTC System to the New York MTA.[18] As shown in the picture to the right, Metrom has installed the AURA PTC System along the F and G subway lines in a residential section of Brooklyn along 3 km of underground track between Church Avenue and 4th Street – also known as the "Culver Test Track." As all operations are underground and heavily shielded by the subway tunnels, the risk of harmful interference to authorized systems is minimal and to date there have been no reported incidences of harmful interference. Metrom Rail has set up a series of 16 UWB anchors on the test track, approximately 200 meters apart, located along the subways walls. These anchors are used for determining train speed, position, direction,

[17] *See* 47 C.F.R. §2.106.
[18] *See* experimental STA, Call Sign WM9XLZ.

and track ID by interacting with an UWB equipped train as it travels down the tunnel. This information can then be utilized for train spacing and control functions.

II. Request for Waiver.

The Commission may grant a waiver of its rules if good cause is shown.[19] More specifically, the Commission may grant a request for waiver if it is shown that: (i) the underlying purpose of the rule(s) would not be served or would be frustrated by application to the instant case, and that a grant of the requested waiver would be in the public interest; or (ii) in view of unique or unusual factual circumstances of the instant case, application of the rule(s) would be inequitable, unduly burdensome or contrary to the public interest, or the applicant has no reasonable alternative.[20] As discussed below, Metrom believes that grant of its waiver request would serve the underlying purpose of the rules and is in the public interest to promote safety in accordance with government mandates along the nation's rail lines.

Metrom has identified that it needs a waiver of Sections 15.519(a) and (c) of the Commission's rules to fully optimize the AURA PTC System to provide maximum benefits as expeditiously as possible and at the lowest cost to rail systems to ensure enhanced safety to protect lives and property:

- Section 15.519(a) specifies that UWB devices operating under this section must be handheld and may not employ a fixed infrastructure.[21]
- Section 15.519(c) specifies radiated emission limits for UWB devices operating under this section and sets the maximum average effective isotropic radiated power ("EIRP") in the 3100-10600 MHz band at -41.3 dBm.[22]

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[19] *See* 47 C.F.R. §1.3.
[20] *See* 47 C.F.R. §1.925.
[21] *See* 47 C.F.R. §15.519(a).
[22] *See* 47 C.F.R. §15.519(c).

As stated, Metrom believes grant of its waiver request will not undermine the fundamental purposes of the rule and is in the public interest.

A. Section 15.519(a) Should Be Waived to Permit Use of the AURA PTC System.

When the Commission adopted the rules for UWB communications systems in 2002, it stated that outdoor operation in the 3.1-10.6 GHz band may only occur if the system consists of handheld devices that may be employed for such activities as peer-to-peer operation.[23] In applying that rule, the Commission defined handheld devices as portable devices, such as a lap top computer or a PDA, that are primarily handheld while being operated and that do not employ a fixed infrastructure when operating outdoors.[24] The Commission also noted that, in an abundance of caution, it adopted the most stringent UWB rules with the most conservative out-of-band emissions ("OOBE") mask for these devices.[25] Further, these limitations essentially prohibited the creation of networks, such as wide area networks, to prevent large numbers of devices in close proximity and thereby minimize the potential of causing harmful interference to existing authorized services.

As noted, the AURA PTC System consists of a UWB module mounted on a train and wayside signal modules installed along the track right of way. Thus, a waiver is needed to permit use of a handheld UWB device while permanently mounted on a train and to allow use of fixed infrastructure for these handheld devices. As an initial matter, all AURA PTC System devices, except as noted in Section B below , comply with all other applicable UWB rules, such as the EIRP limit, OOBE limits, ceasing transmission if there is no acknowledgement from a

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[23] *See* Revision of Part 15 of the Commission's Rules Regarding Ultra WideBand Transmission Systems, ET Docket No. 98-153, *Report and Order*, 17 FCC Rcd 7435 (2002) at ¶5 ("UWB Order"). Codified at 47 C.F.R. § 15.503.
[24] *Id.* at ¶20. Codified at 47 C.F.R. § 15.519(a).
[25] *Id.* at ¶67.

receiver, etc. In addition, all AURA PTC System UWB modules incorporate the already Commission-approved Time Domain PulsON module.

1. The AURA PTC System Devices are Functionally Equivalent to Handheld UWB Devices.

The use of the both train-mounted handheld UWB devices and permanently fixed wayside UWB devices does not undermine the intent of the underlying rule. The rules for handheld UWB devices state that these devices are relatively small devices that are primarily handheld. The AURA hardware solution is relatively small; the train mounted unit pictured on page 6 measures 16" x 8" x 10" and the trackside anchor pictured on page 9 measures 8" x 8" x 12 And, while the Commission states that these devices should be primarily handheld, it does not require them to be.[26] The AURA PTC System devices are consistent with the Commission's rules and meet the intent of limiting the use of UWB. However, instead of sitting on a desk, they are placed on a train or trackside. Thus, there is no functional difference between a strictly handheld device as contemplated by the Commission and the AURA PTC System devices. Indeed, one could analogize a similar system where the train engineer had a handheld device or laptop with the same UWB transmitter in the train cab. That would be permitted under the rules without a waiver. However, such a system would be impractical and compromise safety as removing some of the system automation could distract the engineer from the primary task of keeping an eye on the tracks to safely control the train. Using a permanently mounted handheld UWB transmitter on the train is the best solution and merits the requested waiver.

Moreover, the Commission requires UWB devices used for measurement and communications to operate in peer-to-peer mode and not establish wide-area communications.[27]

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[26] *See* 47 C.F.R. § 15.519(a) & 15.503(m). The rule provides examples of types of devices that qualify under the handheld UWB rules, but does not present an exhaustive list.
[27] *Id.*

The AURA PTC System operates in just such a way. Transmissions between the train-mounted UWB device and the wayside UWB device occur on a peer-to-peer basis. As the train travels down the track, it establishes communications with two wayside devices that relay signal information, such as speed limitations and stop conditions, back to the train-mounted device. As the train passes that wayside device, it breaks and establishes communications with the next wayside device further down the tracks to get updated signaling instructions. In such a way, the system works by establishing consecutive, short duration peer-to-peer connections and not wide-area networks. And, because these transmissions are limited to the track rights-of-way, they are not widespread across large areas. Thus, the potential for causing harmful interference to authorized services is minimal.

2. Fixed Infrastructure Would Not Increase the Risk of Harmful Interference.

The Commission should issue a waiver that allows the trackside devices to be installed as fixed infrastructure. The Commission adopted stringent rules for handheld UWB devices in an abundance of caution to reduce the risk of causing harmful interference to primary services.[28] Permitting wayside track units to be installed at known fixed points along railroad rights-of-way will not increase this risk. As an initial matter, many of these systems will operate within the confines of underground subway tunnels, which will contain the signal and prevent it from reaching outside areas. The equipment used by Metrom for these fixed locations has been certified by the Commission, and has therefore demonstrated compliance with the Commission's OOBE limits that protect adjacent band services, including GPS.[29] Because these UWB devices comply with the Commission's strict OOBE rules, there is little risk of harmful interference to

[28] UWB Order at ¶18.

[29] Metrom has attached to this waiver request the equipment certification testing for the UWB module that will be used. This report demonstrates that the equipment meets the OOBE limits and restricts emissions into the GPS band well below the protection requirements.

any other communications system installed within these tunnels (*e.g.*, Cellular, PCS, AWS, Wi-Fi).

Similarly, even when the trackside devices are installed in outdoor locations, the risk of interference to other, primary services remains extremely low. The AURA PTC System only operates along train rights-of-way, so the location of these devices is known, transmitted signals are localized along the tracks, and in many places are shielded by buildings, trees, and other man-made and natural structures. Additionally, these devices are typically mounted low to the ground -- between 2 and 12 feet high -- and propagation in the 3.1-5.3 GHz band is limited to short ranges which further reduces the potential for interference. In this regard, Metrom has been operating under these parameters while testing under its current experimental STA and there have been no reports of harmful interference from any licensee of an authorized service.

3. There Are No Reasonable Alternatives to Using the 3.1-5.3 GHz Band.

In choosing to develop the AURA PTC System, Metrom set out to develop a PTC solution that was low cost and could be installed quickly to provide maximum safety benefits to rail systems as expeditiously and efficiently as possible. Local rail systems in Boston, New York, and Los Angeles have tested this product and found that it greatly improves the safety and reliability of their rail systems. Approval of limited waivers of the Part 15 rules will allow the contracting process to continue for these cities and permit the use of this life-saving technology that greatly improves the effectiveness of these rail systems in an expeditious and cost-effective manner. By choosing to base the AURA PTC System on UWB technology, Metrom could meet those goals as the Time Domain PulsON UWB technology is proven, reliable, accurate, relatively low cost, and does not pose any appreciable risk of causing harmful interference.

The 3.1-5.3 GHz band was the best choice for the AURA PTC System as the equipment is readily available and the propagation characteristics provide a balance between meeting the demanding performance requirements of PTC and minimizing the potential of causing harmful interference to authorized users. While Section 15.515 of the Commission's rules authorizes use of the 22-29 GHz band for vehicular UWB systems UWB systems operating under those rules are limited to field disturbance sensors.[30] Moreover, the Commission recently decided to phase out the rules for vehicular UWB devices in the 22-29 GHz band in favor of moving all such radars up the 76-81 GHz band.[31] Thus, the provisions of Section 15.515 do not provide a viable option for the intended service.

Further, the 76-81 GHz band to which vehicular UWB devices were relocated is also not a viable option as those rules are limited to radar systems, which would preclude the communications functionality of the PTC system. Also, the 76-81 GHz is a restricted band subject to the provisions of Section 15.205.[32] Therefore, the communications function of the system would need to operate in a separate frequency band as no emissions other than spurious emissions are permitted to occupy the 76-81 GHz band. Finally, the 220 MHz band in which many PTC systems are designed to operate does not pose a viable alternative as it does not solve the issues that Metrom has addressed with the AURA PTC System. Using that band would require significant time to negotiate with existing licensees to acquire spectrum rights along the track rights-of-way, which also adds considerable cost to the system. Even more importantly,

[30] *See* 47 C.F.R. § 15.515(a).
[31] *See* Amendment of Parts 1, 2, 15, 90 and 95 of the Commission's Rules to Permit Radar Services in the 76-81 GHz Band, ET Docket No. 15-26, Report and Order, 32 FCC Rcd 8822 at ¶27 (2017).
[32] *See* 47 C.F.R. §15.205.

the narrowband nature of systems operating under those rules,[33] does not allow for the full suite of functions that the AURA PTC System can provide.

The AURA PTC System operating in the 3.1-5.3 GHz band is clearly the best (and most practical) alternative for meeting railroad safety requirements in a low cost, quick deployment solution.

B. Section 15.519(c) Should Be Waived to Permit the AURA PTC System to Operate with 6 dB Additional Gain For Some Limited Directional Antenna Applications.

The AURA PTC System will employ two different antenna types – an omnidirectional antenna and a directional antenna. The omnidirectional antenna is the Time Domain Broadspec UWB Antenna, which is designed to be used with the PulsON 400 series of UWB modules.[34] These antennas will be used with the AURA PTC System modules mounted on the wayside signaling modules. The EIRP from the omnidirectional antennas will comply with the -41.3 dBm requirement of the Commission's rules and no waiver is necessary. However, some modules will also utilize a directional antenna. The directional antenna was used in the Boston tests with the MBTA, was used for demonstration testing in Los Angeles, and is being used in the current testing being done under Metrom's STA in New York for operation with the MTA. This antenna has an 80-degree beamwidth at the half power point with vertical polarization. Metrom requests that transmissions from this directional antenna be permitted to exceed the current limit in the Commissions' rules by 6 dB to produce an EIRP of no more than -35.3 dBm. OOBE from this antenna will comply with all Commission rules for UWB devices so there is no

[33] The rules for the 220-222 MHz band are based on 5 kHz channels most of which can be aggregated to larger channels. The channels are assigned in pairs with the 220-221 MHz band available for base stations and the 221-222 MHz band available for mobile and control stations. *See* 47 C.F.R. §§ 90.715 and 90.733(d).

[34] Specifications for the Broadspec UWB Antenna are available at https://timedomain.com/wp-content/uploads/2015/11/320-0385C-Broadspec-Antenna-Data-Sheet.pdf.

additional risk of interference to adjacent services. There have been no reports of harmful interference during either the MBTA tests in Boston, the demonstration in Los Angeles, or the MTA tests in New York.

Extensive testing has shown that the use of the directional antenna to supplement the omnidirectional antenna is necessary to gain additional signaling range for the AURA PTC System to ensure that trains moving at top speed have sufficient distance to slow down or stop completely to avoid any possibility of a collision with other trains or people. Metrom's tests have shown that the directional antenna offers a range increase of over 50% (improving range from approximately 900-1000 feet to 1200-1300 feet), which will result in less wayside radios being required thereby reducing deployment costs while increasing the margin for safety in a cost-effective manner that will not increase the potential for causing harmful interference to authorized services.

The 3.1-5.3 GHz band is comprised of several sub-bands that comprise a mix of various services. On a primary basis, this band contains federal allocations for the Radiolocation, Maritime Radionavigation, Aeronautical Radionavigation, Fixed, and Mobile services. And, on a primary basis, the band contains non-federal allocations for the Fixed, Mobile, and the Fixed Satellite (downlink) Services. The Radio Astronomy, Aeronautical Mobile, Aeronautical Mobile Satellite (R), and Aeronautical Radionavigation and Radionavigation Satellite services are shared on a primary basis at the upper end of the band.

The AURA PTC System's use of a directional antenna with 6 dB additional EIRP does not pose any increased risk of harmful interference to any of these services. First, UWB is designed to minimize the potential for causing harmful interference. The PulsOn UWB module uses short duration pulses, coherent signal processing and repetition rates of 10 MHz, with a duty

cycle of under 1 percent. It establishes independent communication channels by pseudo-randomly encoding and modulating the phase, position, and/or repetition rate of the pulse train to produce a noise-like signal that is spread evenly over 1 to 2 GHz of bandwidth.

As noted, the UWB modules with these directional antennas will be located along railroad rights-of-way, greatly limiting their locations. Additionally, these directional antennas will be mounted close to the ground and will be aimed down the track to provide the strongest signal possible towards the train to maximize range. The antenna pattern of the directional antenna which keeps both horizontal and vertical energy within a tight envelope, ensures this is the case. Further, the wayside units transmit only for short durations and only after receiving a signal from an approaching train. Under the UWB rules, a handheld UWB transmitter must cease operating within 10 seconds if it does not receive an acknowledgement from its associated receiver.[35] The AURA PTC System is designed to fully comply with that rule. All these factors along with the extremely low power and low duty cycle combine to produce a PTC system operating in the 3.1-5.3 GHz band that has negligible, if any, potential to cause harmful interference to authorized systems in the band, even when operating with an additional 6 dB EIRP.

More specifically, the factors described above along with the nature of the existing authorized services act to reduce the potential for harmful interference. For example, the Radiolocation services generally are looking for targets in the air, not on the ground where the rail system is located. Thus, the signals will be sufficiently separated so that there is little chance of a PTC system causing harmful interference. Likewise, for the Radio Astronomy service. radio telescopes are aimed towards the sky and are generally located in quiet areas far from train

[35] *See* 47 C.F.R. §15.519(a)(1).

tracks. These factors will prevent harmful interference from occurring to any Radio Astronomy operations. We note that some of the Radionavigation services may have downward looking receivers, but their associated transmitters are generally very strong. The very low power along with the vertical suppression of energy in the upward direction from the AURA PTC System wayside antennas and the noise-like UWB signal should pose no risk of co-channel interference. This is because any airborne receiver will generally be high above any train tracks, and with the high propagation loss in this band, any energy that might be transmitted in their direction should be undetectable by their receivers.

Finally, with respect to the fixed and mobile services, we recognize that these systems are also located close to the ground and may cross or even follow railroad tracks. However, as borne out by Metrom's extensive testing in Boston, Los Angeles, and New York, the risk of causing harmful interference to these services is also low. Fixed systems, even when pointed along a train track tend to be located much higher than the ground to avoid clutter and other effects from nearby objects. The PTC system will operate close to the ground, which will provide separation from these signals. In addition, because there is flexibility in where the wayside signaling transmitters are placed, they can be located to ensure that there is no boresight-to-boresight coupling and to minimize any power from sidelobes that may be pointed towards a fixed antenna.

For mobile systems, PTC signals are very low power and of very short duration and localized to areas near a moving train. Because mobile systems are also generally operating in motion, the duration of co-location from any given mobile station should be very short. Additionally, mobile systems operate at much higher power levels than the AURA PTC System will ever approach. For example, the Citizen's Broadband Radio Service in the 3550-3700 MHz

band permits mobile transmitters to operate with a maximum EIRP of 23 dBm/10 megahertz (20 mW/megahertz) and base stations with up to 47 dBm/10 megahertz. Thus, the mobile station's signal can be over 6 billion times stronger than that of the UWB signal, even when operating with 6 dB over the limit allowed by current rules.[36] Thus, even operating in close proximity, the mobile signal will overpower the UWB signal to successfully communicate with its associated base station. Yet, the directional nature of the UWB signal will help prevent any authorized system, including mobile systems, from causing interference to the AURA PTC System.

For all the reasons stated above, there is little risk of causing harmful interference to any other system operating along with the AURA PTC System within the 3.1-5.3 GHz band. Therefore, the Commission should waive Section 15.519(c) to permit the AURA PTC System to obtain an equipment authorization grant for operations up to -35.3 dBm. A waiver permitting the operator of any AURA PTC System — either Metrom or the local rail or transportation authority – to operate such systems under the handheld UWB rules of Section 15.519 at EIRP levels up to -35.3 dBm would serve the public interest as it would allow for the beneficial control of trains to protect public safety.

III. Precedent for Requested Waiver

The Commission has a history or permitting rule waivers when good cause and benefits to the public interest are shown. This is especially the case where such waiver promotes safety of life and property, permits innovative solutions, and will not cause an increase to harmful interference. The AURA PTC System is consistent with that precedent. Some examples of prior Commission waiver grants that are analogous to the waivers requested here are:

- Amtrak (ET Docket No. 16-415) – In this waiver of the 5 GHz U-NII rules, the Commission permitted Amtrak to operate its point-to-point system to deliver Wi-Fi to

[36] The comparative level of signals is calculate by comparing the 30 nanoWatt/Megahertz UWB signal to the 23 dBm/10 Megahertz (20 mW/Megahertz) mobile signal – (30*10^-9) / (20*10^-3) = 6.57*10^9.

moving trains where a radio mounted on a moving train would communicate with trackside fixed transmitters mounted on masts and located along track traversing the Northeast corridor under the rules governing fixed point-to-point systems. The Commission reasoned that such operation was permissible because Amtrak's operation bore many characteristics of a fixed point-to-point network and that the access points and train-based radios would be exclusively within the bounds of the track right of way and operate in a highly direction manner.[37]

- iRobot Corporation (ET Docket No. 15-30) – In this waiver of the 6 GHz rules, the Commission waived the prohibition on the use of fixed outdoor infrastructure to allow iRobot to obtain equipment certification for and market a robotic lawn mower.[38] The Commission concluded that, when taking into account the variability in propagation characteristics due to terrain, low antenna heights and other propagation factors, grant of this waiver is very unlikely to increase the potential for harmful interference.

- PTC-220 LLC (WT Docket No. 13-59) – The Commission waived the power and antenna height limits in the 220 MHz band to facilitate PTC deployments by enabling a larger coverage footprint. The Commission found that such action would serve the public interest by promoting innovative and efficient spectrum use as well as improving rail safety, including the safety of life and property.[39]

- Curtis-Wright Controls Inc. (DA 07-198) – The Commission permitted higher emissions for a fixed surveillance UWB imaging system in the 1.99-3.65 GHz band to allow greater range partially due to the directionality of the antennas in both the azimuth and horizontal direction as well as limiting where they would be deployed. In addition, Curtis-Wright offered an unrivalled technological solution.[40]

- Kyma Medical Technologies Ltd (ET Docket No. 15-119) – In this waiver of the UWB rules, the Commission permitted Kyma to operate a UWB medical imaging system between the 530 MHz and 2105 MHz band rather than in the 3100 to 10,600 MHz band required for such systems under the rules.[41] In granting this waiver to permit operation in a different frequency band, the Commission reasoned that the potential from interference resulting from operating in the 530 MHz-2105 MHz frequency range can be balanced by operational and technical restrictions.

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[37] *See* Amtrak Request for Waiver, ET Docket No. 16-415, Letter from Julius P. Knapp, Chief, Office of Engineering and Technology, FCC to Robert D. Primosch, Counsel for Amtrak dated Jun 1, 2017, 32 FCC Rcd 4592 (2017).

[38] *See* iRobot Corporation Request for Waiver of Section 15.250 of the Commission's Rules, ET Docket No 15-30, Order, 30 FCC Rcd 8377 (2015).

[39] *See* PTC-220, LLC, Request for Waiver to Facilitate Deployment of Positive Train Control Systems, WT Docket No. 13-59, Memorandum Opinion and Order, 30 FCC Rcd 2281 (2015).

[40] *See* Curtis-Wright Controls Inc., Embedded Computing Petition for Waiver of the Part 15 Ultra-Wideband (UWB) Regulations, DA 07-198, Order, 22 FCC Rcd 815 (2007).

[41] *See* Kyma Medical Technologies Ltd. Request for Waiver of Part 15 of the Commission's Rules Applicable to UltraWideband Devices, ET Docket No. 15-119, Order, 31 FCC Rcd 9705 (2016).

Consistent with the prior Commission precedent, as detailed above, the AURA PTC System should similarly be permitted. The AURA PTC System is an innovative and cost-effective solution to preventing tragedies along the nation's rail lines. The use of handheld units as fixed infrastructure and the modest increase in power requested for some transit transmitters will not increase the potential for harmful interference. As the Commission found when issuing the waivers cited above, the AURA PTC System promotes the safety of life and property, the transmitters will be low to the ground, deployed in limited areas within railroad rights-of-way, and have propagation characteristics in which the signal will attenuate quickly. As the Commission has similarly found before in analogous waiver cases, it should conclude here that a grant of waiver for the AURA PTC System is in the public interest.

IV. Locations

As previously stated, Metrom has been working closely with the Boston MBTA and the New York MTA and has conducted extensive testing with both authorities. Each are interested in pursuing installation of the AURA PTC System more widely across their rail systems and commencing regular operation. Thus, while Metrom would prefer the Commission permit nationwide operation for any rail system under the requested rule waivers, Metrom would be amenable to a more limited waiver to operate across the MBTA and MTA rail systems initially followed by Los Angeles Metro. Once Metrom demonstrates successful operation and that there are no adverse effects to any authorized service operating in the 3.1-5.3 GHz band, it would ask that the Commission broaden the waiver to permit nationwide operation. For example, the Commission could permit such expansion of locations to occur automatically should Metrom receive no complaints (or no complaint that it cannot expeditiously resolve) of harmful interference within six months (or any other period amenable to the Commission) after beginning operation in the MBTA or MTA system or LA Metro. Or, if the Commission wishes to take a

more conservative approach, Metrom could provide notice prior to installing a system and commencing operations at other locations; a list of those systems using the AURA PTC System can also be maintained on Metrom's website. The AURA PTC System will provide important public safety benefits within any community where it is installed, and it is in the public interest to provide authority to install and operate this system across as many rail systems as quickly as possible.

V. Conclusion.

Grant of the requested waiver of Sections 15.519(a) and (c) would serve the public interest by providing an innovative, low cost, quick-to-install option for rail systems to allow entities providing regularly scheduled intercity or commuter rail passenger transportation to have a PTC system installed. Additionally, the AURA PTC System will reduce rail operating costs and enhance public safety by preventing rail accidents involving people or other railcars. Metrom urges the Commission to expeditiously review and approve this request for waiver.

Respectfully Submitted,

/S/Richard Carlson Sr.

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September 4, 2018

cc: Julius Knapp
Ronald Repasi
Aspasia Paroutsas
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Michael Ha
Karen Rackley
Hugh Van Tuyl
Ronald Williams

ATTACHMENT

GPS TESTING RESULTS FOR TIME DOMAIN PULSON 440 UWB MODULE FCC ID Number: NUF-P440-A

5 Radiated emissions in GPS receive band

5.1 *Test Result*

Test Description	Reference	Test Result
Radiated emissions in GPS receive band	15.519(d)	Compliant

5.2 *Test Method*

In addition to the radiated emission limits specified in the table in paragraph (c) of this section, transmitters operating under the provisions of this section shall not exceed the following RMS average limits when measured using a resolution bandwidth of no less than 1 kHz:

Frequency (MHz)	EIRP dBm	EIRP ($dB_{\mu}V/m$) at 3m	EIRP ($dB_{\mu}V/m$) at 1m
1164–1240	-85.3	9.9	19.4
1559–1610	-85.3	9.9	19.4

5.3 *Test Site*

3m Absorber Lined Shielded Enclosure, SGS EMC Laboratory, Suwanee, GA

Environmental Conditions
Temperature: 24.0°C
Relative Humidity: 32 %

5.4 *Test Equipment*

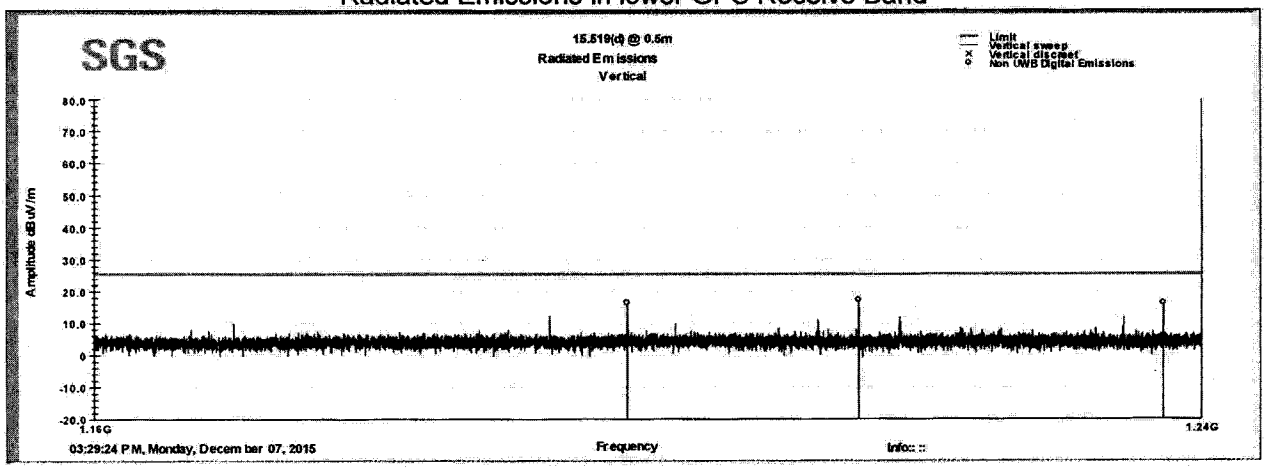
Test Date: 7-Dec-2015 Tester: D Schramm

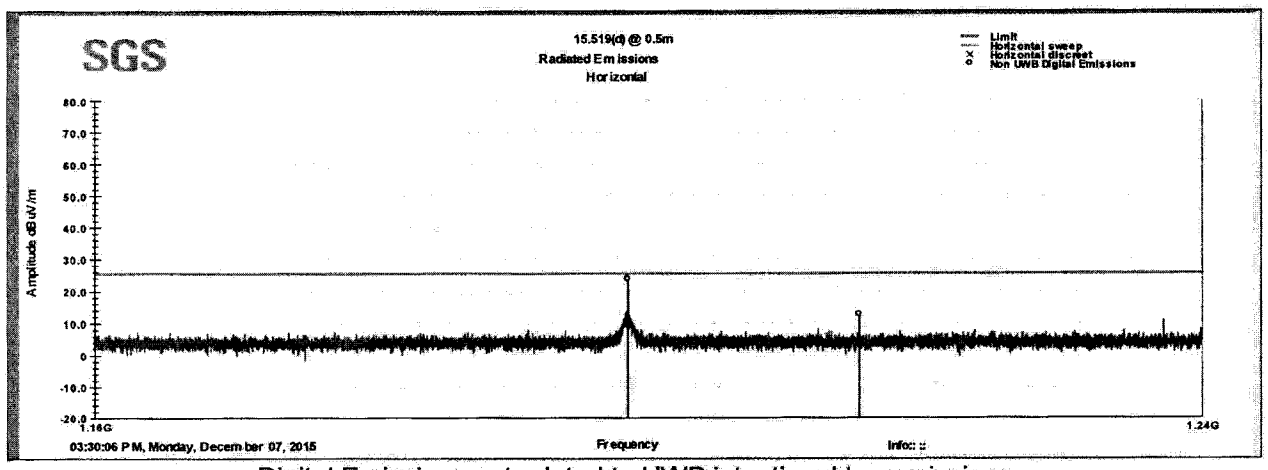
Equipment	Model	Manufacturer	Asset Number	Cal Due Date
EMI TEST RECEIVER	ESU40	ROHDE & SCHWARZ	B079629	4-Aug-2016
DRG HORN (MEDIUM)	3117	ETS-LINDGREN	B079691	9-Jul-2016
PREAMPLIFIER-ANTENNA SYS	TS-PR18	ROHDE & SCHWARZ	15003	24-Aug-2016
RF CABLE	NMS-290-236.2-NMS	FLORIDA RF LABS	B095020	4-Aug-2016
TYPE N CABLE	104PE	HUBER&SUHNER	B079793	4-Aug-2016
FILTER	LPM17270	MICRO-TRONICS	B093646	5-Aug-2016

Note: The calibration period equipment is 1 year.

5.5 *Test Data*

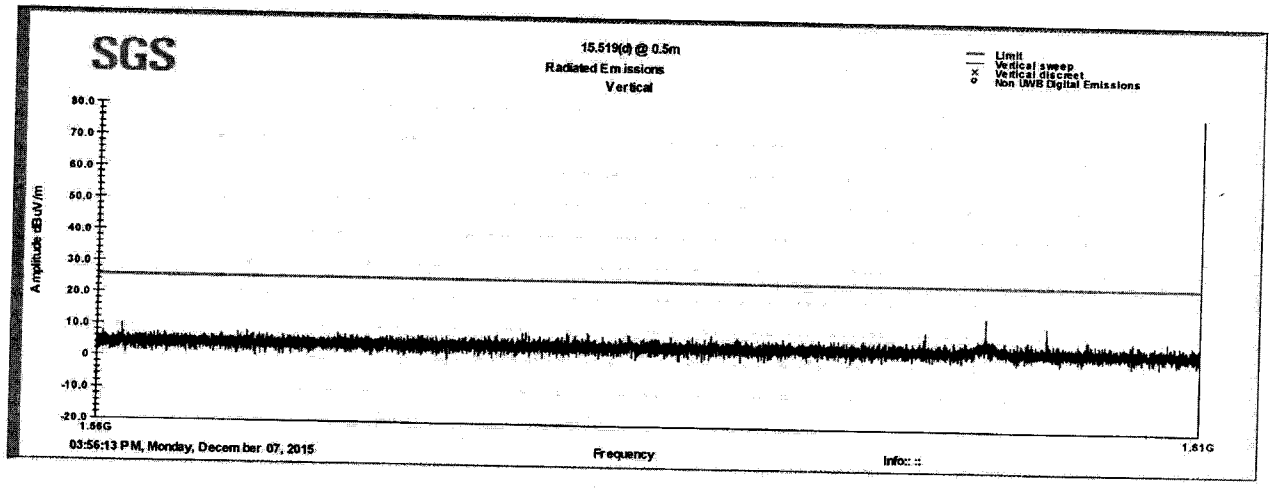
Radiated Emissions in lower GPS Receive Band

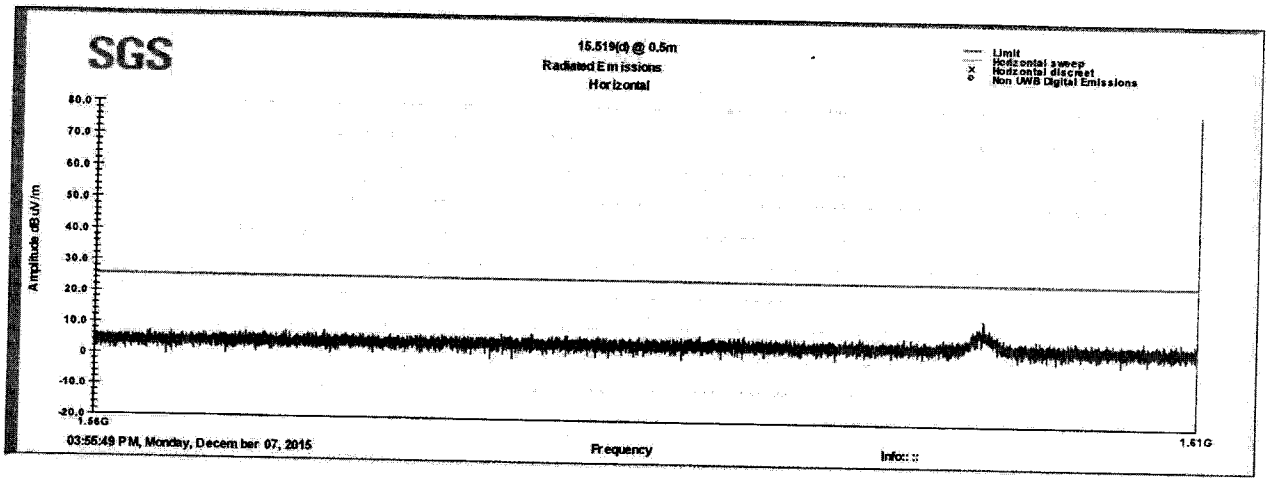




Digital Emissions not related to UWB intentional transmissions

Plot: Radiated Emissions in upper GPS Receive Band





Data: Radiated Emissions in GPS Receive Bands

Upper

Frequency MHz	Level dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	CL (dB)	Amp (dB)	RMS Value dBuV/m	Limit (dBuV/m)	Margin dB
1583.65	15.6	V	107.0	100.0	29.2	2.5	40.4	6.9	19.4	-12.6

Frequency MHz	RMS Value dBm	Limit (dBm)	Margin dB
1583.65	-97.9	-85.3	-12.6

Frequency MHz	Raw RMS dBuV	Polarity (V/H)	Azimuth (degrees)	Height (cm)	AF (dB/m)	CL (dB)	Amp (dB)	RMS Value (dBuV/m)	Limit (dBuV/m)	Margin (dB)
1583.65	18.2	H	283.0	125.0	29.2	2.5	40.4	9.5	19.4	-9.9

Frequency MHz	RMS Value dBm	Limit (dBm)	Margin dB
1583.65	-95.2	-85.3	-9.9